Balancing Design Requirements for a Potential CO_2 Injection Well based on Intended Future Use, Technical Soundness, and Regulatory Requirements

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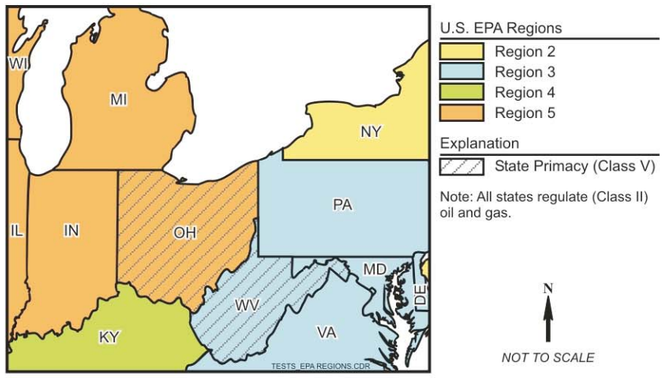
Abstract

Sequestration of carbon dioxide in deep saline formations is an emerging practice and, as such, regulatory agencies are making an effort to address the injection well design issues for the planned injection demonstrations while developing guidance for the longer-term technology deployment. The geologic storage projects for MRCSP spans three different U.S. EPA regions, with varying degree of primacy granted to state regulatory agencies for UIC wells. State DNR offices may also have regulatory authority over installation and construction of CO_2 test or injection wells, even under the current guidance that allows an experimental status for CO_2 storage wells.

While the involvement of several different regulators and numerous other stakeholders can make negotiations complex, it provides flexibility to ensure that a potential CO_2 injection well design complies not only with local, state, and regional regulatory requirements but also with good technical standards as gleaned from local experience with other types of wells. We use examples from recent well installations to discuss how this regulatory environment has affected test well planning and installation throughout the MRCSP region, including:

- Building consensus for the proposed design among regulatory agencies and other stakeholders.
- Evaluating and negotiating changes to the installed design in response to actual geologic conditions encountered in the field.
- How local experience, individual agency input, and field conditions affects final well design as compared to broader design drivers, such as regional geology and intended use.

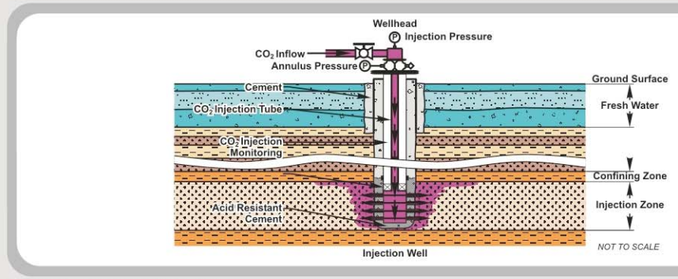
This collaborative design process allows input of best practices at all stages of the project, permits incorporation of technological advances where practical, and prevents delays or potential problems in permit reviews.



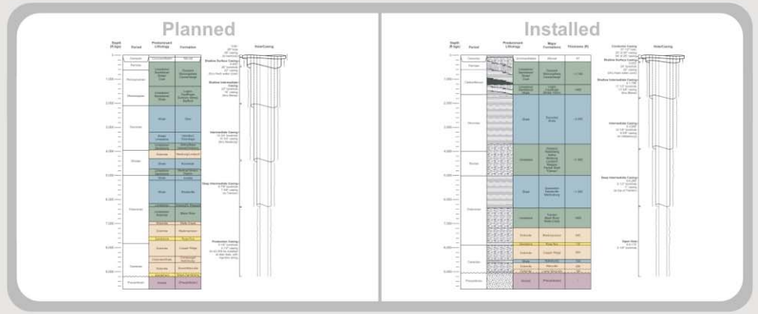
State and regional primacy for the regulation of carbon dioxide sequestration test wells throughout the MRCSP region.

Regulators are working to establish guidance for the construction and operation of carbon sequestration test wells at the same time test wells are being installed in their states or regions. Battelle, after consultation with state and regional agencies, has adopted a stepwise approach to drilling CO_2 test wells across the region:

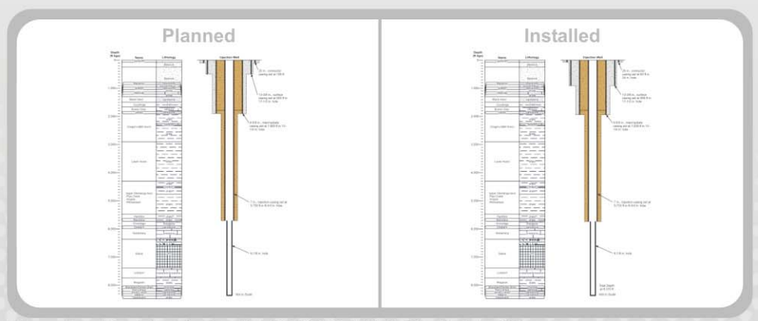
- All regulatory agencies that may be affected by a specific drilling project are brought into the planning and design process as early as possible.
- Planned end use for the well and how it drives well design and required permits is negotiated.
- The test well is permitted through that particular state's DNR as a stratigraphic test well.
- Field conditions encountered during well drilling and testing and its impact on the well design, data collection, and planned future well use is again discussed with all affected regulatory agencies.
- Injection test wells will be permitted through state or regional UIC programs, which have been providing feedback on the test well since the preliminary design stage.



Conceptual test well design.



Planned and installed test well. AEP 1 Well, New Haven, WV.

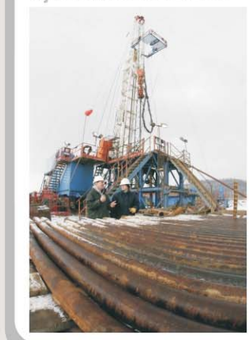


Planned and installed test well. FEGENCO 1 Well, Shadyside, OH.

Two examples of how well designs were changed in response to new data and stakeholder input are shown here. Some changes include:

- The alluvium was deeper than expected, requiring an additional conductor casing and a second look at planned casing sizes at the AEP1 well.
- A field decision was made to extend the FEGENCO1 shallow casing from 500 ft to over 900 ft after the local DNR inspector indicated that a sensitive red shale layer around 600 to 800 ft needed to be behind surface casing.
- After encountering very weak lower Ohio shales at the AEP1 well, an agreement was reached to set casing upon reaching competent rock rather than drilling to the original planned depth. The planned depth would have put an additional formation behind the intermediate string to counter potential problems downhole.

Injection Well Installation



CO_2 Treatment

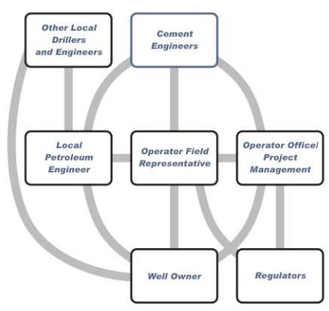
AEP1 Well

FEGENCO 1 Well

Example of Stakeholders Consulted for a Proposed Design Change

The test well design process requires the collaboration and buy-in of regulators, experts, and stakeholders. This allows both the flexibility to respond to actual conditions encountered in the field while ensuring that stakeholder and regulator concerns are addressed. One example of Battelle's consensus-building process is summarized here:

- When running the surface casing, one of the regulators raised concerns over planned curing time of the cement, since the well might have a future use as a CO_2 injection well. Local oil and gas industry standard is to wait 8 hours before tripping in. Battelle's cementing plan called for waiting 12 hours to allow for a safety margin.
- Consultations between cement engineers, local oil and gas engineers and geologists, and local and state regulators ensued, coordinated by Battelle staff. After examining the scientific basis behind the standard industry practice, the various stakeholders agreed to allow a cure time of 24 hours.
- Though the consensus-building process appears cumbersome, implementation usually goes smoothly and it has thus far been an invaluable tool in maintaining stakeholder buy-in and good relations with regulatory agencies and host sites.



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